

The Impact of Fluctuating USD/RMB Exchange Rate on the Yields and Volatility of Chinese Concept Stocks

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Abstract. The currency exchange market plays a critical role in international trade, but it has fluctuated more frequently since the trade conflict between the U.S. and China. By collecting the daily exchange rate of the U.S. dollar (USD) against the Chinese yuan (RMB) and the NASDAQ OMX China Technology index (CHXN9000) from September 25, 2017, to January 25, 2020, this paper empirically analyzes the dynamic response of the Chinese Concept stock yields to RMB's exchange rate changes using VAR and ARMA-GARCH models⁴. The results of the study show that (1) the increasing exchange rate yields of USD to RMB (depreciation of RMB) and the Chinese concept stock yields are negatively correlated in the short term; (2) Chinese concept stock returns respond significantly to the exchange rate volatility, but this effect gradually disappears after the fourth period. These findings may serve as instructive aid to investors in choosing their portfolios while facing exchange rate fluctuations.

Keywords: Chinese concept stock; Exchange rate; VAR model; ARMA-GARCH model.

1. Introduction

The international currency system is essential in how well trade and capital move between countries. Nor pointed out that exchange rate volatility has been increasing due to the expansion of international trade and fiscal and monetary policies assumed by the governments of each country [1]. Since March 2018, the United States and China have been embroiled in a trade conflict characterized by high retaliatory tariffs. From July 2018 to September 2019, the United States implemented five rounds of tariff increases on Chinese exports, and China responded with retaliation at each stage [2]. During the intensified period of the trade war between the U.S. and China, the elasticity of the RMB exchange rate has tightened and is remarkably sensitive to market information. Kun Qian stated that the tariff gamble between the U.S. and China has a prominent impact on the instability and behavior of the exchange rate; each emergence of major events in the trade conflict is generally associated with the devaluation and elevated volatility of the RMB [3].

In recent years, there has been a growing recognition that changes in exchange rates can affect the stock market and the value of corporations. Given the increasing integration between the foreign exchange market and the stock market, as well as the prevalence of hedging and diversification policies, it is necessary to examine the degree of influence between these two distinct markets. In the context of the current U.S.-China trade conflict and the COVID-19 pandemic, changes in the RMB exchange rate and equity markets are important to the global economy. Furthermore, Chinese companies listed in the U.S. or those whose main business is foreign trade economy are more exposed to exchange rate fluctuations. Accordingly, this paper aims to empirically investigate the impact of fluctuating USD/RMB exchange rate on the yields and volatility of Chinese stocks listed in the U.S. exchanges under the US-China trade friction, thus being able to help stock investors choose the appropriate investment portfolio while substantially hedging the possible investment risks and ensuring their profitability in case of exchange rate fluctuations.

In a pioneering study, Dornbusch and Fischer proposed a theoretical assumption that there exists an impact of exchange rate fluctuations on the stock market from the perspective of the trade balance [4]. As a principal determinant of international trade, variations in the exchange rate directly influence the competitive edge of domestic products in the global market, thereby impacting movements in imports and exports. The volatility of inflows and outflows product quantities will unavoidably impinge on the manufacturing and operating performance of multinational corporations, thus causing

changes in companies' stock prices. In addition, changes in exchange rates are not only associated with the transaction costs and risk exposures of corporations denominated in foreign currencies – they may also induce domestic inflation by adjusting the prices of imported products. And in accordance with Ibrahim and Agbaje, inflation creates uncertainty in the economy, discouraging local and foreign investors with regard to investing as it may adversely affect their payoffs [5]. The wavering in investment decisions of potential investors is related to the general demand and supply of stocks, thus resulting in stock market price destabilization [6].

Many scholars have conducted empirical studies related to the association between the foreign exchange market and the stock performance based on different economies and currencies. However, the empirical results of the relationship between these two are inconsistent because of the diversity of the real situation. Griffin and Stulz proposed that even if exchange rate shocks are crucial for manufacturing industries reliant on international trade, the economic implications on US industries are trivial [7]. Studies such as Lee and Suh focused on the US multinationals' profitability from 1984 to 2002 and find that stock returns of multinationals were not dramatically driven by volatile exchange rates [8]. Conversely, Doukas et al. found a significant association between simultaneous equity returns and JPY dynamics for multinationals and high-exporting Japanese corporations listed on the Tokyo Stock Exchange [9], and they further substantiated this finding at the industry level in 2003 [10]. Later, Dewenter et al. found evidence supporting a synchronous relationship between stock returns and exchange rates in both the Mexico and Thailand [11]. Yousuf and Nilsson examined the spillover effect between exchange rates and stock returns using the GARCH (1,1) model and Pearson correlation coefficient. Their findings indicated that changing exchange rates would affect stock market's future performance [12].

Most of the current research demonstrates that cause-and-effect linkages exist between exchange rates and stock markets. Whereas, there is also a divergence of conclusions in relevant studies concerning whether the relationship between exchange rates and stock returns is positive or negative when it comes to the temporary and persistent relationships. Liu Lin, Meng Yu, and Yang Kun applied the threshold co-integration analysis and the time-varying parameter VAR model with non-constant volatility to explore the nonlinear long-term correlation between the exchange rate and the stock price [13]. The conclusion presented a prolonged negative and time-variant interaction between the two, that is, the depreciation of RMB can cause the stock price to increase. By testing the GARCH-in-Mean model, another study conducted by Weihai Zhang and Peijuan Yang also investigated the correlation between exchange rates and stock markets over the long period [14]. They found that Chinese stock market and exchange rate market present a bi-directional influence mechanism, and even though the appreciation of the RMB will cause the stock to fall over the long haul, the fluctuation of the exchange rate market exerts a relatively faint bearing on the trends of the stock market. In terms of the short term, Shen Wang and Shigui Tao concluded the positive causality between the RMB/USD exchange rate and stock prices since the appreciation in the RMB will lead to inflows of short-term international capitals [15], which then promotes the increase in stock prices.

Although the existing pieces of literature commendably contribute to the investigation into the links between exchange rates and the stock market, most of the available research focuses on historical data from 2017 and before, therefore the timeliness is insufficient. Studies addressing the impact of import and export restrictions and exchange rate swings on the equity market during the recent US-China trade war are lacking. This paper fills this void by employing the data from the pre-and post-period of the US-China trade war. Meanwhile, most of the past literature conducted studies with listed companies in Shanghai or Shenzhen Stock Exchange, but this study selects Chinese concept stocks (stock of companies operating domestically and listed overseas) as the study sample. Besides, this paper applies the ARMA-GARCH model to predict the dynamic response of Chinese concept stock yields to volatile exchange rates rather than the reaction of general stock prices in the Chinese stock market, which has been discussed mainly in the past.

Following is an overview of the paper's remaining parts: the second part is the research design, which contains data description and sources and introduction of the unit root test, VAR model, and

ARMA-GARCH model; the third part includes estimation results of the ADF test, VAR, impulse response, and ARMA-GARCH; the fourth part is the discussion; the fifth part is the conclusion.

2. Research Design

2.1 Data Description

For the purpose of examining the exposure of exchange rate fluctuations on the yield of Chinese concept stocks (CCS) during the US-China trade conflict, the study made use of daily data from September 25, 2017, to January 25, 2020, as a sample, covering the exchange rate sourced from the China Foreign Exchange Trade System and the stock index collected from Nasdaq. After taking the logarithmic difference of the two variables, a sample of 609 daily yields can be obtained. The exchange rate is the nominal exchange rate of the U.S. dollar to the Chinese yuan (USDCNY) offshore. The stock index is the daily closing price of NASDAQ OMX China Technology (CHXN9000), which is aimed at monitoring the performance of technology companies that are incorporated in mainland China or Hong Kong.

2.2 Unit Root Test

To further complete the forecasting, the unit root test is adopted to inspect the stationarity in the time series data. Being stationary in a time-series data means its statistic mean, variance and covariance do not vary with time or these statistic properties are not the function of time, otherwise, the series is referred to as non-stationary. For this study, the time series examined are the USD/RMB exchange rate, the CHXN9000 closing price, and the log-returns of these two variables. To determine whether these variables are stationary, the Augmented Dickey-Fuller (ADF) test was applied. In applying the ADF test, the following regression forms are generated:

$$x_t = c_t + \beta x_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta x_{t-i} + \varepsilon_t \quad (1)$$

Where β is the coefficient on the temporal trend, p is the lag order of the autoregressive process, and ε_t is the white noise error. Based on the following hypothesis, the ADF test is performed:

$$H_0: \beta = 1 \quad (2)$$

$$H_1: \beta < 1 \quad (3)$$

To conclude the test, comparing the calculated p-value of the ADF test to the level of significance. If the p-value of the test is less than 10%, then the null hypothesis is rejected and so concluding that the series is stationary, or nonstationary otherwise.

2.3 VAR Model

In this study, a bivariate vector autoregression model (VAR) model is developed to observe the magnitude and persistence of the influence of exchange rate changes on stock price returns. The VAR model has proven to be reliable for depicting and forecasting the dynamic interaction between multiple time series variables. As a widely used classical model for testing macroeconomic problems, VAR does not require a complex basis of financial and economic theories or strong restrictions and relationships. It regresses all current variables in the system on the lagged variables corresponding to all variables, avoiding the complexity of parameter estimation and inference when endogenous variables appear on the either side of the equation. Suppose that $x_{1,t}, x_{2,t}$ are two time-series variables, then the expression for the bivariate VAR(p) system is as follows:

$$x_{1,t} = c + \beta_{1,1}x_{1,t-1} + \beta_{1,2}x_{1,t-2} + \dots + \beta_{1,p}x_{1,t-p} + \varepsilon_{1t} \quad (4)$$

$$x_{2,t} = c + \beta_{2,1}x_{2,t-1} + \beta_{2,2}x_{2,t-2} + \dots + \beta_{2,p}x_{2,t-p} + \varepsilon_{2t} \quad (5)$$

Where $\{x_{1,t}, x_{2,t}\}$ are vectors of two time-series, p refers to the lag order taken in the analysis, β_i are $(k \times k)$ coefficient matrices, and $\varepsilon_{1,t}$ $\varepsilon_{2,t}$ are two $(k \times 1)$ zero-mean white noise processes with a time-invariant covariance matrix. Intended to obtain the lag-order (p) for the VAR model, computing the likelihood ratio (LR), the final prediction error (FPE), as well as the Akaike's, Schwarz's Bayesian, and Hannan and Quinn information criteria (AIC, SBIC & HQIC). And after building a VAR model, the residuals are tested for autocorrelation and whether follow a normal distribution, i.e., if all eigenvalues are located within the unit circle, then the model processing is stationary.

Besides, an impulse response function (IRF) summarizes the time-dependent causal effects between variables when VAR models are used for structural inference. It is as follows:

$$\frac{\partial x_{t+s}}{\partial \varepsilon_t} = \varphi_s \quad (6)$$

This equation evaluates how much the value of x_{t+s} is affected by the one unit increase of the t -th period disturbance term ε_t , assuming other variables and error terms remain constant in other periods.

2.4 ARMA-GARCH Model

The autoregressive moving average model (ARMA) is an essential model applied to describe time series in terms of the autoregressive (AR) and the moving average (MA) analyses merged. Hence, it forecasts future estimates depending on previous values and error terms. When the variance of the observations shows volatility clustering, the generalized autoregressive conditional heteroskedasticity model (GARCH) is widely used to measure the volatility of returns for financial assets. The GARCH model comprises two parts: the conditional mean equation and the conditional variance equation. Moreover, fitting the heteroskedasticity with the GARCH avoids the degradation of the fitting accuracy when there is a larger lag order. By replacing the conditional mean equation as an ARMA process, an ARMA-GARCH model with explanatory variables added to the variance equation is obtained to predict the volatility of the CHXN9000 returns. The construction of the ARMA-GARCH model is as follows:

$$x_t = \phi_0 + \sum_{i=1}^m \phi_i x_{t-i} + \varepsilon_t + \sum_{j=1}^n \theta_j \varepsilon_{t-j} \quad (7)$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^q \gamma_j \sigma_{t-j}^2 \quad (8)$$

Where x_t is the observed realized return at time t , ϕ_0 is the constant, ϕ_i is the autoregressive coefficient, θ_j is the moving average coefficient and ε_t is the white noise; σ_{t-j}^2 is the lagged conditional variance at time t , α_0 is the constant, α_i is the associated constant, and ε_t^2 is the squared error at time t , γ_j is the autoregressive coefficient. Note that m and n in (7) represent the number of autoregressive and moving average terms; and the p and q in (8) describe the number of lags for the error and conditional variance, respectively.

3. Empirical Results

3.1 ADF Test

This paper selects two variables, the USD/RMB exchange rate and the CHXN9000 stock closing price, from the interval September 25, 2017, to January 25, 2020, to conduct an empirical study. Since the construction of the VAR model requires certain stability of data, while most time series of macroeconomic variables appear to be non-stationary, the series needs to be confirmed the presence of stationarity and processed in advance. The ADF unit root test is performed with Stata and the results are shown in Table 1:

Table 1. ADF Test

Variables	t-statistic	p-value
	Price	
CHXN9000	-2.213	0.4826
Exchange rate	-1.692	0.7545
	Yield	
CHXN9000	-16.505	0.0000***
Exchange rate	-18.480	0.0000***

The p-values of the tests for direct prices of CHXN9000 and the exchange rate are much greater than 0.1, thus the null hypothesis of nonstationary cannot be rejected. Further applying the ADF test for log return rates of CHXN9000 and the exchange rate, the p-values approaches to 0; thus, the null hypothesis of the test is rejected at 1% significance level with the conclusion that this series yields are stationary during September 25, 2017, to January 25, 2020 period.

3.2 VAR Order Identification

Table 2. VAR model identification

Lag	LL	LR	p	FPE	AIC	HQIC	SBIC
0	4277.82			1.5e-09	-14.6683	-14.6625	-14.6533
1	4296.71	37.773	0.000	1.4e-09*	-14.7194*	-14.7019*	-14.6744*
2	4299.19	4.9611	0.291	1.4e-09	-14.7142	-14.685	-14.6393
3	4300.06	1.7568	0.780	1.4e-09	-14.7035	-14.6626	-14.2919
4	4301.83	3.5219	0.475	1.4e-09	-14.6958	-14.6432	-14.5609
5	4305.19	6.723	0.151	1.4e-09	-14.6936	-14.6294	-14.5288
6	4306.66	2.9475	0.567	1.4e-09	-14.6849	-14.609	-14.4901
7	4311.07	8.8292	0.066	1.4e-09	-14.6864	-14.5987	-14.4616
8	4313.05	3.9452	0.413	1.5e-09	-14.6794	-14.5801	-14.4247
9	4313.6	1.0969	0.895	1.5e-09	-14.6676	-14.5566	-14.3828
10	4315.04	2.8806	0.578	1.5e-09	-14.6588	-14.5361	-14.3441
11	4316.58	3.0888	0.543	1.5e-09	-14.6504	-14.516	-14.3057
12	4318.85	4.5422	0.338	1.5e-09	-14.6444	-14.4984	-14.2698
13	4320.15	2.6018	0.627	1.5e-09	-14.6352	-14.4775	-14.2306
14	4321.76	3.2141	0.523	1.5e-09	-14.627	-14.4576	-14.1924
15	4323.41	3.2908	0.510	1.5e-09	-14.6189	-14.4378	-14.1543
16	4324.97	3.1304	0.536	1.5e-09	-14.6105	-14.4178	-14.116
17	4325.77	1.6087	0.807	1.6e-09	-14.5996	-14.3951	-14.0751
18	4329.19	6.8344	0.145	1.6e-09	-14.5976	-14.3815	-14.0431
19	4332.43	6.4814	0.166	1.6e-09	-14.595	-14.3672	-14.0105
20	4334.57	4.2724	0.370	1.6e-09	-14.5886	-14.3491	-13.9742
21	4334.94	.74874	0.945	1.6e-09	-14.5761	-14.325	-13.9318
22	4340.82	11.759*	0.019	1.6e-09	-14.5826	-14.3197	-13.9082
23	4342.66	3.6692	0.453	1.6e-09	-14.5752	-14.3006	-13.8708
24	4343.58	1.8506	0.763	1.6e-09	-14.5646	-14.2784	-13.8303
25	4344.68	2.2042	0.698	1.6e-09	-14.5547	-14.2568	-13.7904

Before constructing the bivariate VAR model for the yields of CHXN9000 and the exchange rate, it is necessary to specify the optimal lag order as shown in Table II. Based on the Likelihood Ratio information criterion (LR), it is recommendable to build the vector autoregression model with lag order 22. Next is to check the stability of the constructed VAR (22) model. According to Figure 1, it is observed that all eigenvalues of the companion-form matrix are strictly less than unity in absolute value, which demonstrates that the bivariate VAR (22) model is subject to the stability condition (covariance stationery).

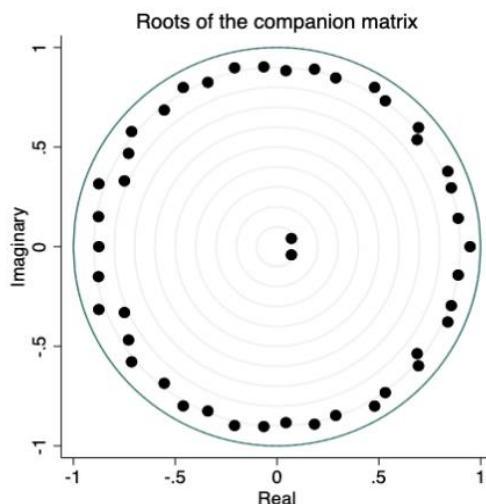


Fig. 1 VAR stability

3.3 Impulse Response

The impulse-response function (IRF), which considers both contemporaneous and lagged responses are presented in Figure 2 to capture dynamic interactions among the endogenous variables over time. According to the graph, the orthogonalized IRF line has a positive slope but becomes flat as the period increases. Since this study uses the U.S. dollar to RMB as the exchange rate variable, an augment in the exchange rate yield indicates the value strengthening in the U.S. dollar and a weakening in the RMB. This signal brings an extremely pronounced response in the financial market with respect to the return of the CHXN9000. The IRF indicates that there is a short-term drag effect on the return of the CHXN9000 when the exchange rate yield increases, which will last for 3 periods and gradually disappear after the 4th period.

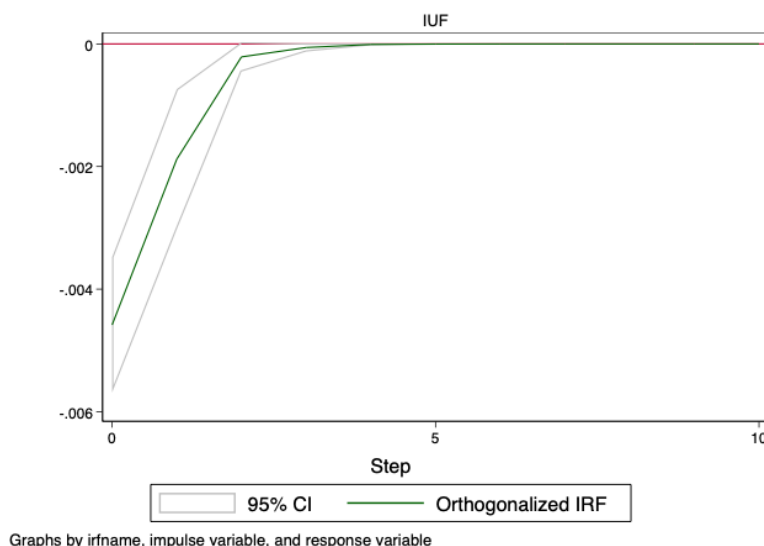


Fig. 2 Impulse and response

3.4 ARMA-GARCH

3.4.1 ARMA Order Identification

In order to identify the order of ARMA model, generating the partial autocorrelation function (PACF) and autocorrelation function (ACF) of the CHXN9000 yields. The stationarity of the parameter is confirmed by ADF test in the previous section. From Figure 1, it can be seen that both PACF and ACF begin to fall in the 95% confidence interval after lag=1. Therefore, selecting lag order 1 for the ARMA for the ARMA-GARCH analysis.

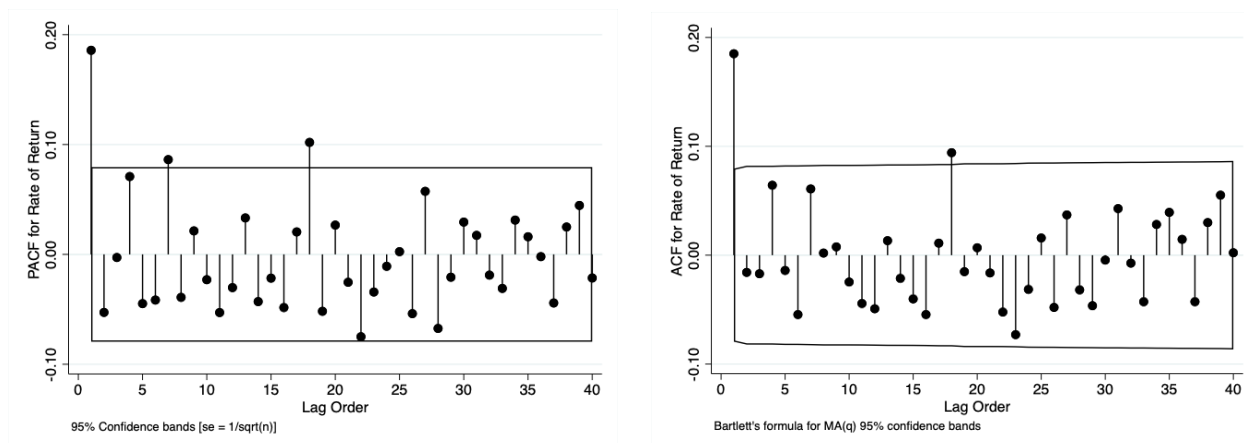


Fig. 3 ARMA order identification, PACF, and ACF

3.4.2 ARMA-GARCH

Before conducting the ARMA-GARCH model. It is not evident from Figure 4 whether the variance is clustering or not, so further tests are needed.

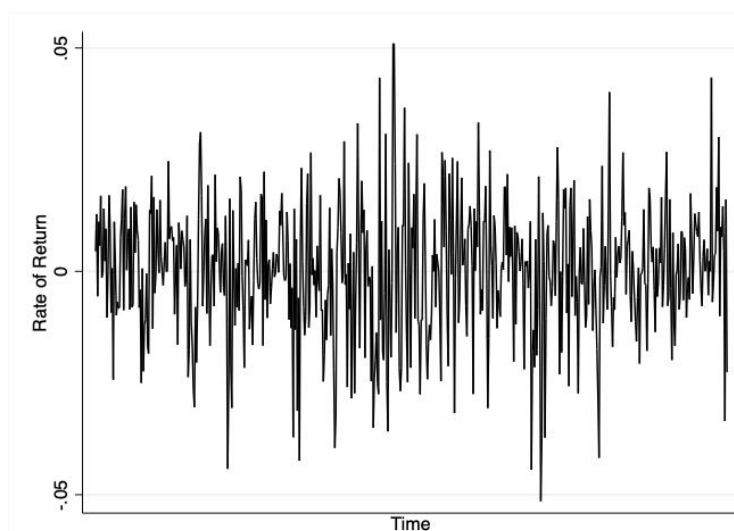


Fig. 4 Rate of return

Table 3 is the estimation result of the variance equation by ARMA-GARCH model. From the results, it can be concluded that there is a significant ARCH and GARCH effect for the CHXN9000 stock returns series, with coefficients significant at least at the 5% level. In addition, the estimation results from the exogenous variables suggest that the changes in the exchange rate cause sharp fluctuations in the stock returns within the current period. Taking column (3) as an example, the coefficient is 180.8012, which is significant at the 5% level. However, there is no lagged effect of such volatility, as shown by the fact that the coefficients are not significant in neither $t=-1$ nor $t=-2$ periods.

Table 3. ARMA-GARCH model estimation results, variance equation

	(1)	(2)	(3)
Exchange rate			
T=0	180.1986*** (51.0784)	182.0445*** (53.7870)	180.8012** (74.8221)
T=-1		-7.8108 (70.8285)	-6.7578 (75.4766)
T=-2			2.0261 (99.7072)
GARCH			
ARCH (-1)	0.0809** (0.0367)	0.0811** (0.0369)	0.0808** (0.0368)
GARCH (-1)	0.7645*** (0.0816)	0.7626*** (0.0832)	0.7635*** (0.0835)
Constant	-10.5043*** (0.3919)	-10.4957*** (0.4128)	-10.4969*** (0.4225)

4. Discussion

This article finds that the exchange rate significantly affected the Chinese Concept Stocks' (CCS) return in the short term. Consistent with the conclusion of the previously mentioned study by Shen Wang and Shigui Tao [15], this paper observes that the return of RMB exchange rate and CCS exhibit a positive correlation in the short run, which means the stock returns will reduce when the RMB depreciates. In addition, the above estimation results indicate that the stock returns respond exceptionally quickly to exchange rate variations in the financial market and this variations cause stock returns volatility, that is, there is a noticeable risk transmission between the two. This finding contradicts the previously mentioned Weihang Zhang and Peijuan Yang's finding that exchange rate fluctuations do not significantly affect stock market movements [14]. The following reasons may explain such a disagreement. First, the sample chosen in this paper is nearly one hundred U.S.-listed Chinese companies, whereas the dependent variable assumed by Weihang Zhang and Peijuan Yang is the Shanghai Composite Index, which has a more considerable volume. Thus, it is plausible that the exchange rate fluctuations manifest a more extensive response in this study. Second, although the relationship between exchange rates and stock prices or returns is time-varying in an equilibrium situation, the linkage between them depends more on the overall macroeconomic environment in China in the long run.

According to the current research findings, the Chinese government needs to mitigate the shock of major international political and economic events on the currency value by further promoting the RMB internationalization and improving the mechanism of the domestic exchange rate formation. When encountering major political or economic events that can drive exchange rate volatility, investors are recommended to forecast trends in the stock market and multinational corporate performance and the exposure to exchange rates from two perspectives: short-term and long-term. Diversifying their investment portfolio or selecting long-term forward investments is appropriate to reduce the risk. From an enterprise perspective, evidence suggests that the main reason for a low aggregate response of firms to exchange rate changes is effective financial and operational hedging [10]. Therefore, a firm is expected to design effective hedging programs for their cash flow to face the significant exchange rate movements, such as adopting a capital structure with less debt.

5. Conclusion

This article attempts to investigate the return response of Chinese Concept Stocks to contemporaneous changes in exchange rate with the ARMA-GARCH model. Based on the empirical results, it can be concluded that: (1) in the short term, an upward movement of USD to RMB exchange

rate yields will lead to a reduction in Chinese Concept Stocks returns; (2) the returns of Chinese Concept Stocks react rapidly and aggressively to the exchange rate volatility but are brief.

Although a dynamic returns response to exchange rate changes exists, this study has limitations in interpreting the exact size and pervasiveness of the reaction of Chinese Concepts Stocks return numerically due to the methodological weakness. Besides, this paper only focuses on the USD/RMB exchange rate, but many other factors can confound a stock's yield. And since the overall sample size of China concept stocks is relatively small, the empirical results may contain bias. Thus, this model can be improved at a later stage by adding more variables, as well as the accuracy of the estimation as the total sample size continues to expand.

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